Towards steering in navigation through 3D environments using GA

Theoretical introduction

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AIL086 Evolutionary Algorithms 2

Outline

Grand Challenge

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- competition of driver-free automobiles

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$\Rightarrow$ steering is essential

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Behaviour model

- **Action selection**: strategy, goals, planning
- **Steering**: path determination
- **Locomotion**: animation, articulation

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- **Action selection**: strategy, goals, planning
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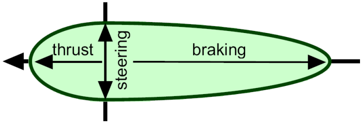
- relatively *fast* motion

A simple vehicle model



- point mass aproximation, without rotational momentum
- **mass** property
- **position** and **velocity** property
- velocity modified by limited forces
- speed is limited
- **orientation**

A simple vehicle model (cont.)

Vehicle model

```
steering_force =
  truncate (steering_direction, max_force)
acceleration = steering_force / mass
velocity =
  truncate (velocity + acceleration, max_speed)
position = position + velocity
```

A simple vehicle model (cont.)

Vehicle model

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steering_force =
  truncate (steering_direction, max_force)
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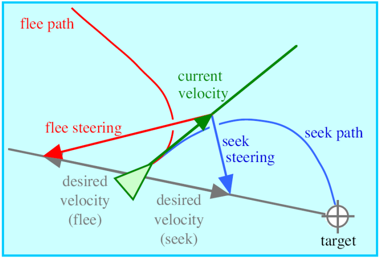
```

- rolling is ignored
- skids, spins, slides etc. cannot be simulated

Outline

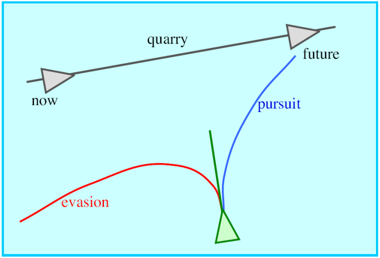
Seek, flee



- **goal** velocity radially aligned towards the target
- **steering force**: difference between character's current and desired velocity

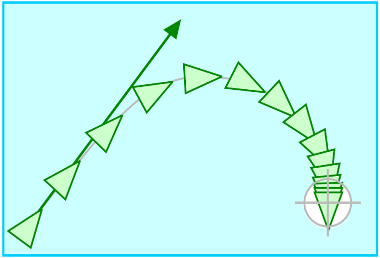
```
desired_velocity =
  normalize (position - target) * max_speed
steering = desired_velocity - velocity
```

Pursuit, evasion



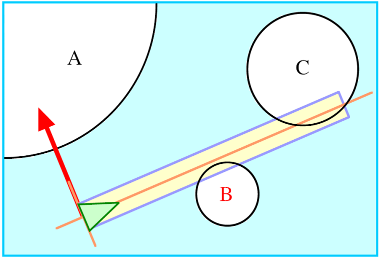
- **pursuit** is seeking a moving target
- requires effective prediction of the target's future position (e.g. target's future position is guessed after a specified time interval T, assuming constant speed and direction)

Arrival



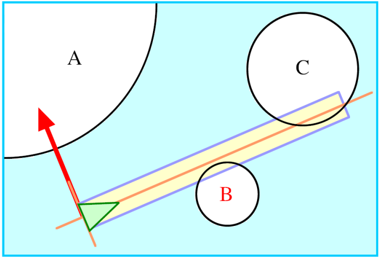
- similar to **seek**, but the desired velocity at the target is 0
- e.g. linear lowering the velocity inside a given radius around the target

Obstacle avoidance



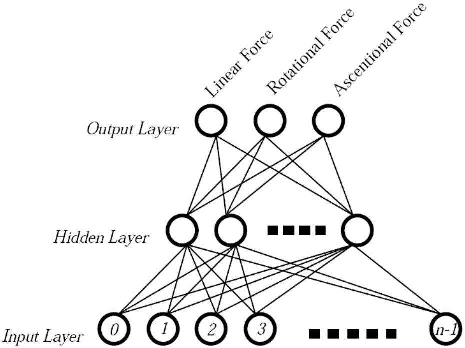
goal: imaginary cylinder of free space in front of the character
cylinder: diameter equal to the character bounding sphere, length depends on speed

Obstacle avoidance (cont.)



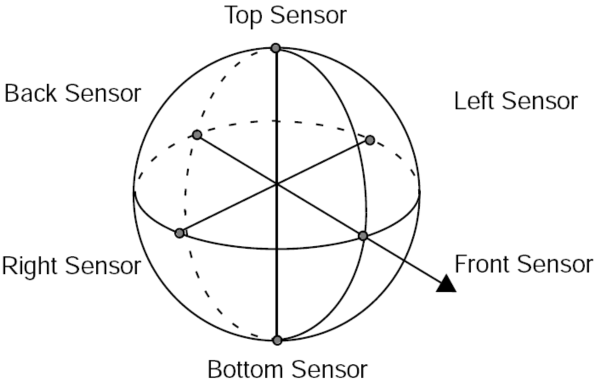
- intersections between obstacle and character is computed and the nearest obstacle is chosen as the most threating
- vectors parallel to intersections are projected to the *up–side* plane of the character
- steering forces are determined

(Not) Evolving Collective Behaviours in Synthetic Fish

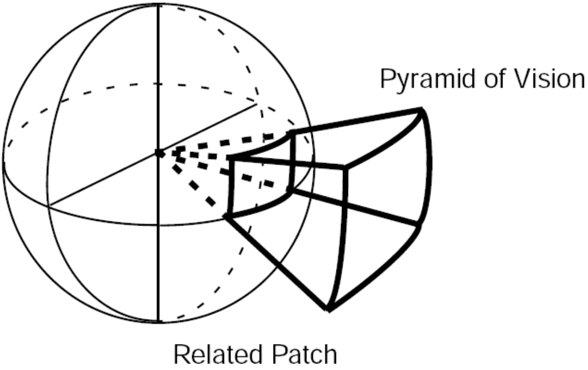


http://www.hpl.hp.com/techreports/96/HPL-96-04.html

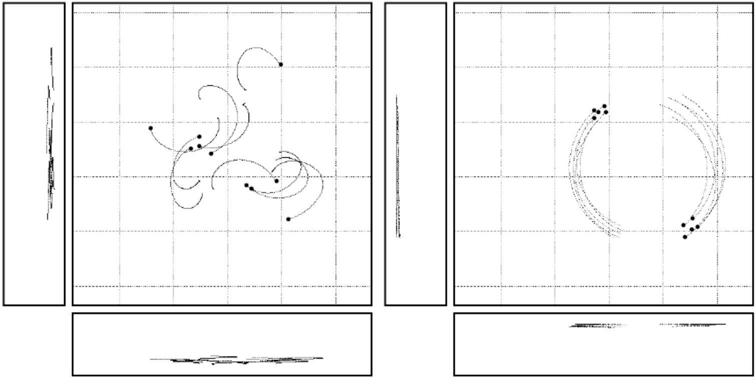
(Not) Evolving Collective Behaviours in Synthetic Fish (2)



(Not) Evolving Collective Behaviours in Synthetic Fish (3)



(Not) Evolving Collective Behaviours in Synthetic Fish (4)



Automatic parking Volvo, Uni. of Linköping

http://www.ikp.liu.se/evolve/

Other related works

Evolutionary learning in mobile robot navigation

http://www.acm.org/crossroads/xrds8-2/evolution.htm

Collision avoidance control of ship with genetic algorithm

http://ieeexplore.ieee.org/Xplore/login.jsp?url=/ie

Ant Colony Optimization

http://iridia.ulb.ac.be/~mdorigo/ACO/publications.h

Other resources

- Reynolds, C. W. *Steering behaviours for autonomous characters*. Aviable at http://www.red3d.com/cwr/papers/1999/gdc99steer.html (5.5.2005)
- Vogel, D. *Evolving steering behaviours with genetic programming*. Aviable at http://www.nonsequitoria.com/2521/ (5.5.2005)